TABLE 1

Silicon doping levels needed to alleviate silica and silicon-containing
ceramics or ceramic composite surface recession loss under different
turbine operating conditions.

Fuel Type	Stoichiometric Ratio (Phi)	Air/Fuel Ratio (By Weight)	Water Level in gasses (Vol %)	Pressure (atm)	Temp. (° C.)	Silicon Levels Required (ppm)	
						In Fuel	In Air
Natural	0.250	68.7	5.1	15	1100	6.5	.10
Gas	0.250	68.7	5.1	15	1200	9.1	0.13
	0.250	68.7	5.1	15	1300	12.3	0.18
	0.250	68.7	5.1	15	1400	15.9	0.23
	0.325	52.8	6.6	15	1100	8.4	0.16
	0.325	52.8	6.6	15	1200	11.8	0.22
	0.325	52.8	6.6	15	1300	15.8	0.30
	0.325	52.8	6.6	15	1400	20.5	0.38
	0.400	42.9	8.1	15	1100	10.3	0.24
	0.400	42.9	8.1	15	1200	14.4	0.34
	0.400	42.9	8.1	15	1300	19.3	0.45
	0.400	42.9	8.1	15	1400	25.1	0.58
	0.250	68.7	5.1	1	1200	0.6	0.01
	0.250	68.7	5.1	10	1200	6.1	0.09
	0.250	68.7	5.1	20	1200	12.2	0.18
	0.250	68.7	5.1	30	1200	18.3	0.27
Liquid	0.250	57.1	3.1	15	1100	2.0	0.03
Fuel	0.250	57.1	3.1	15	1200	2.7	0.05
	0.250	57.1	3.1	15	1300	3.7	0.06
	0.250	57.1	3.1	15	1400	4.8	0.08
	0.325	44.0	4.0	15	1100	2.5	0.06
	0.325	44.0	4.0	15	1200	3.5	0.08
	0.325	44.0	4.0	15	1300	4.8	0.11
	0.325	44.0	4.0	15	1400	6.2	0.14
	0.400	35.7	4.9	15	1100	3.1	0.09
	0.400	35.7	4.9	15	1200	4.3	0.12
	0.400	35.7	4.9	15	1300	5.8	0.16
	0.400	35.7	4.9	15	1400	7.5	0.21

Benefits to protect the silica and silicon-containing ceramics and composites can also be obtained at lower silicon levels than those shown in Table 1. Some reduction will occur at silicon levels below those in Table 1. Table 2 show the effect of the silicon level on the reduction of the recession loss rate. Table 2 demonstrates that the recession loss problem can be fully prevented theoretically. However, in practice a 100% reduction of recession loss may not be achievable. Also, higher silicon levels, up to a factor of about 5 to about 10, than those shown in Tables 1 and 2 might be needed because of the slow rate of volatilization of silicon additives and because of different operating conditions of turbines than those shown in Tables 1 and 2.

TABLE 2

Effect of silicon level in combustion air on reduction in surface
recession rate in silicon-containing ceramics*

Silicon Level	0.00	0.05	0.10	0.15	0.20 (ppm) in air
% Reduction	0.0	22	45	67	90

*Pressure = 15 atm, Phi = 0.325 (stoichiometric ratio of fuel to air), Temperature = 1200° C.

To further demonstrate the invention, and in no way limiting the invention, the following examples are presented.

EXAMPLE 1

A piece of sintered silicon carbide was heat treated in a steam environment at 1200° C. The sample was 1 inch by 0.5 inches by 0.1 inch and a small hole was drilled at one end to suspend the sample from a platinum wire. The sample was held in a vertical tube furnace with an alumina muffle. The atmosphere was provided by flushing the tube with a mixture of 90% steam and 10% oxygen. The weight of the sample was recorded prior to the experiment. During the exposure, the sample was periodically taken out of the furnace and weighed. Results of the experiment are shown in FIG. 1. It can be seen that the sample is continually loosing weight. When silicon carbide is oxidized, the specimen gains weight. The weight loss is due to the reaction of the silica film with water which results in the removal of the film. The weight loss due to reaction of silica with water overwhelms the weight gain from the oxidation.

EXAMPLE 2

Another silicon carbide sample, similar in every respect to example 1, was heat treated at the same temperature in the same atmosphere. However, the gas was saturated with silicon prior to contacting the sample. Saturation of the gas with silicon was obtained by passing gas through a silica sponge held at the same temperature as the sample. The results of the exposure in silicon-saturated steam are shown in FIG. 2. The silicon carbide sample is showing continuous weight gain. The weight gain is due to oxidation of silicon carbide.

These examples show that saturation of the steam with silicon effectively prevents reaction of silica and water that results in mass loss of silicon carbide.

What is claimed:

1. A method to reduce material loss of silicon-containing ceramics and silicon-containing ceramic composites in a